Assessing the effects of sub-lethal doses of pesticides on bee populations

Xavier Reboud

ASIRPA

Socio-economic Analysis of Impacts

of Public Agronomic Research

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This case illustrates an example of an ecological study conducted by two units of the Plant Health and Environment (SPE) division in close collaboration with technical institutes and professional partners, leading to major changes in French national and European policy regarding the use of certain pesticides.

Context

Since the 1990s, France, like other countries, has been facing a general decline in bee colonies, the causes of which remain largely unknown. The scientific community tends to attribute this phenomenon to a multitude of factors, including the emergence of new diseases, the decline of exploitable food sources, and the presence of toxic substances in the environment. A few catch phrases from militant environmentalists have made bees the icon of a healthy environment in the public eye, which renders the subject particularly sensitive. Halting the decline of bees has therefore become a public policy issue.

Inputs

In France, less than ten research teams focus on honeybees, with INRA in a leadership position. Faced with such complex challenges, INRA and the SPE division have adopted a policy of efficiency by concentrating the issue on two sites, Avignon and Magneraud (in collaboration). The Avignon unit, now entirely dedicated to bees, has changed its name to "Bees and the Environment"; the Magneraud experimental unit "Entomology" is now focusing on developing skills in toxicology, and in bee ecology in a large-crop agro-environment. Because the demographic breakdown in bee colonies concerns the relationship between bees and their environment, the focus was more explicitly put on acquiring skills in bee ecology. In addition, the site in Avignon welcomed representatives of the bee industry in a joint technological unit (UMT PrADE), bringing together INRA, ITSAP, ACTA (network of institutes in the animal and plant sectors) and Adapi (French Association for the development of beekeeping in Provence). In parallel, INRA units have benefited from exceptional support in terms of recruitment, both scientific and technical.

Outputs

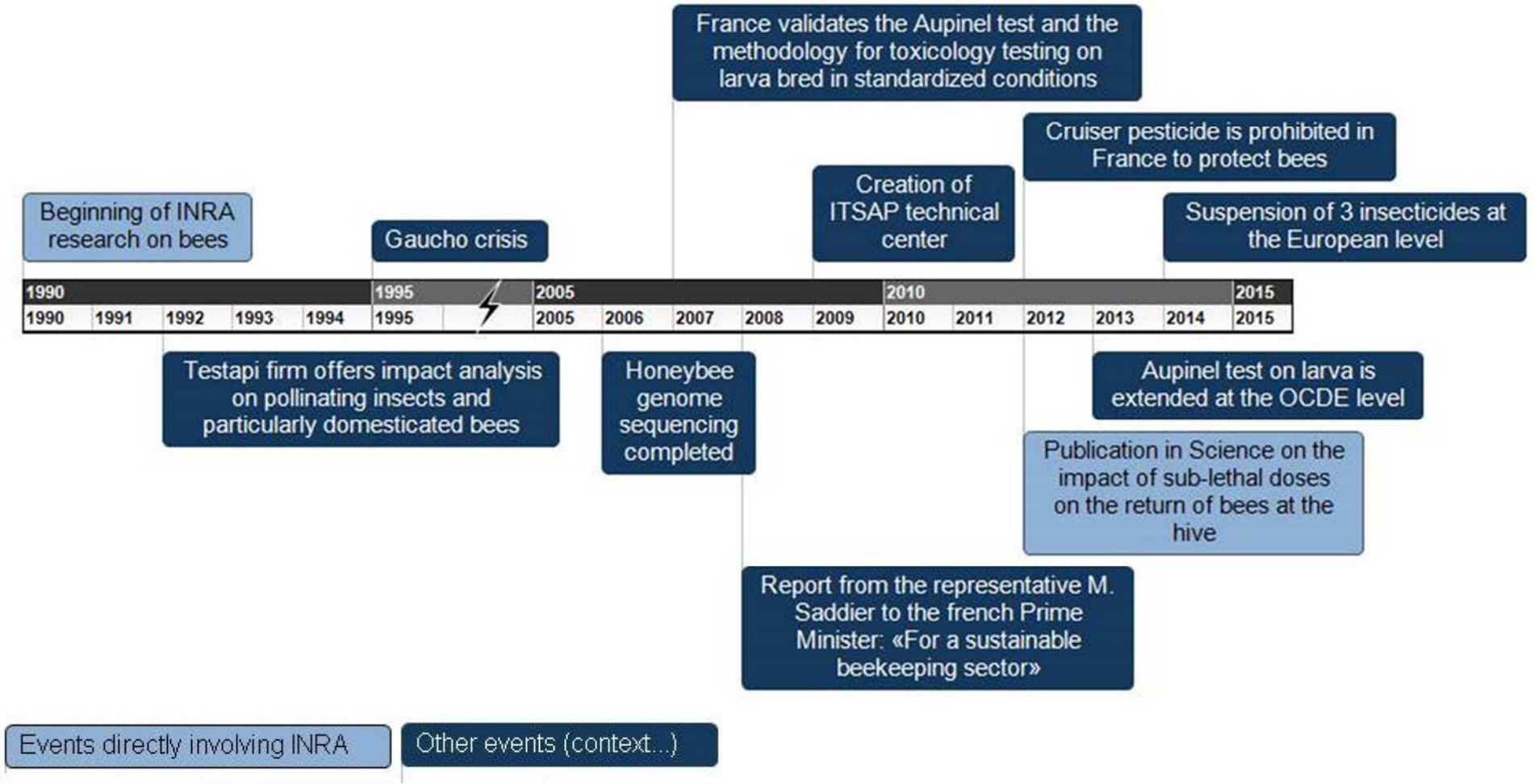
Using an innovative methodology in which RFID microchips are attached to the backs of 650 forager bees to monitor their comings and goings at the hive, the research consortium produced precise data that shows how sub-lethal doses of pesticides affect the functioning of beehives, not in terms of direct toxicity but by disturbing the orientation of the foragers and their ability to find their way back to the hive. This destabilising of the colony may make it more vulnerable to other stress factors such as pathogens (varroa, nosema, virus), or variations in the availability of natural floral resources. These findings have been published by M. Henry and his colleagues in the March 29, 2012 issue of the journal Science. Realizing the controversial nature of the article, the journal editorial board organised a press conference. Almost immediately, the French minister announced its decision to prohibit the use of certain pesticides in France. Upon the request of experts for pesticide approval, the

experimental unit in Magneraud developed a standardised *in vitro* test for bee larvae in conditions where exposure to the pesticide is controlled. This test is easy transferable to accredited laboratories in charge of evaluating pesticides. This method was referenced in the BEEBOOK (manual of experimental protocols) and by the OECD. An advantage of this method is that the product can be tested for the 6-7 days of larval life before the pupal stage begins. The test thus gives information on the delayed effects on pupal and adult stages. These studies began with a strictly regulatory goal. They now pave the way for more scientific studies on the delayed effects that stress factors encountered at the larval stage have on adult bees.

Intermediaries

The geographic proximity of research and development was instrumental in bringing complementary skills together and helping to create support projects. This was especially the case for perfecting RFID technology. The *in vitro* test on larvae filled a recognized need, and was approved by the French Commission for biological testing (CEB) in March 2007, under the condition that an inter-laboratory test confirms its accuracy and reliability. This test involved a dozen French and European labs, both public and private, and findings were published in 2009. The last step was approval at global level by the OECD in July 2013. The test has been approved by the European Food Safety Agency, thereby becoming the benchmark for approving new chemicals to promote plant health. APINOV, a start-up, has positioned itself in the niche market of using bees as harbingers of the environment. The company provides services to local authorities, and proposes to set up fully equipped beehives to monitor the environment on susceptible industrial sites. The product is protected by specialized know-how and INRA interpretation software (non-exclusive licence agreement on INRA intellectual property n°12009SF).

Chronology


France validates the Aupinel test and the methodology for toxicology testing on larva bred in standardized conditions
Cruiser pesticide is prohibited in France to protect bees
Creation of ITSAP technical center
Suspension of 3 insecticides at the European level
Beginning of INRA research on bees
Gaucho crisis
1990
1995
2005
2010
2015
1990 1991 1992 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Testapi firm offers impact analysis on pollinating insects and particularly domesticated bees
Honeybee genome sequencing completed
Aupinel test on larva is extended at the OCDE level
Publication in Science on the impact of sub-lethal doses on the return of bees at the hive
Report from the representative M. Saddier to the french Prime Minister: «For a sustainable beekeeping sector»
Events directly involving INRA
Other events (context...)

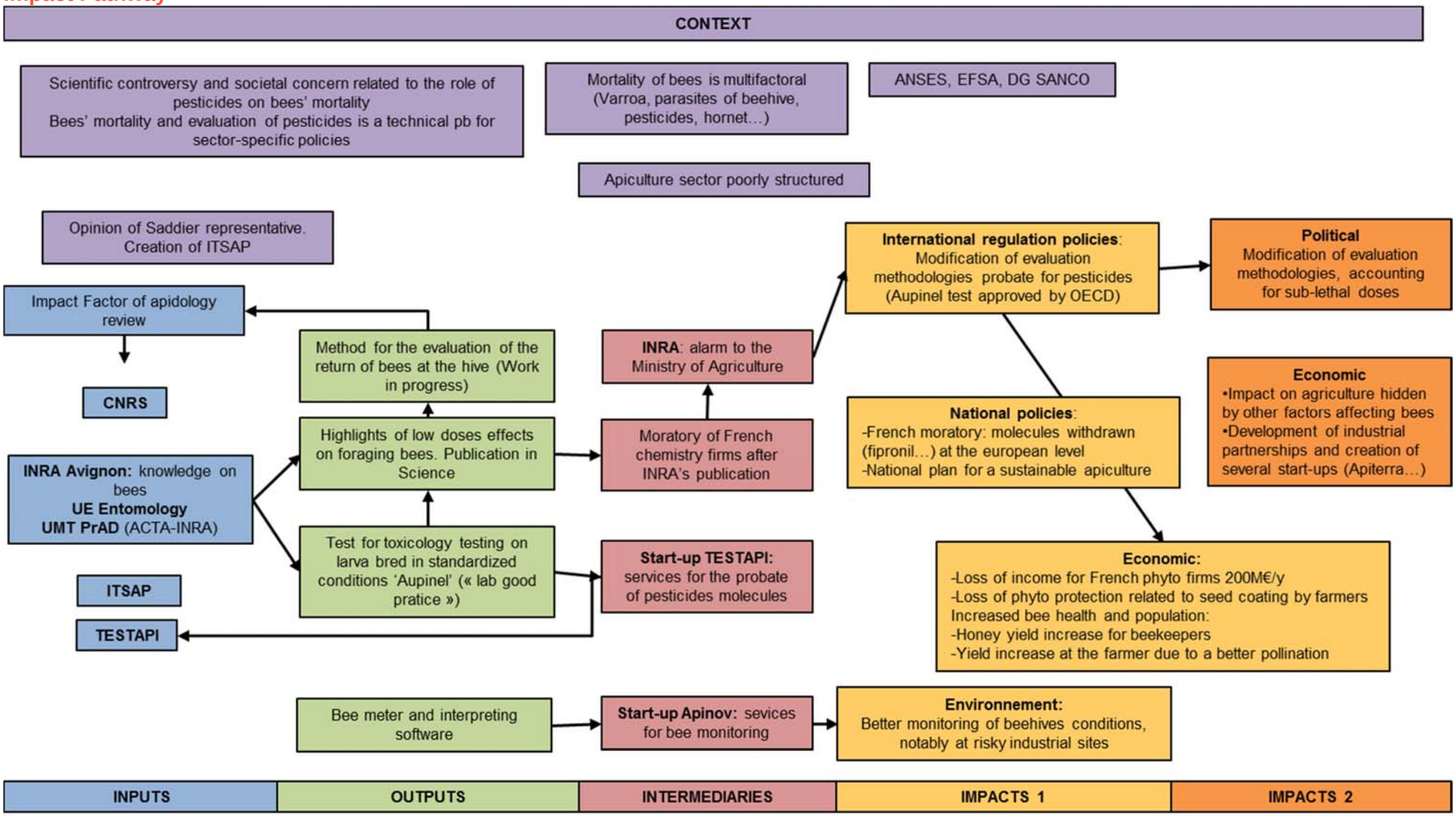
Impacts 1

In 2010, the government presented a national plan for the sustainable development of beekeeping. The plan consists of 17 points, and relies heavily on the scientific findings produced by INRA. In 2012, the French ministry of agriculture issued decrees restricting the use of Fipronil and a second chemical. When iconic chemicals were withdraw from the plant protection companies Syngenta and BASF, their reaction was scathing, eliciting general disapproval from part of the agricultural sector. Throughout 2012 and 2013, French authorities defended, at European level, their position of prohibiting of various active substances. On January 1, 2014, Europe as a whole followed suit, banning the use of the same products. Private suppliers then stepped in to perform tests for market release authorization: TESTAPI in France, IBACON GmbH in Germany, and another company in England. They all possess the know-how in terms of certified methods for conducting the necessary tests, in particular on toxicological safety for larvae. APINOV, a company specializing in beekeeping, uses the technology developed in these projects to provide services to industrialists whose sites pose a particular risk. Hives equipped with counters winned the gold medal for innovation at the 2013 World Beekeeping Awards, APIMONDIA. Bio-surveillance activities based on bees has created some dozen new jobs and is on the rise.

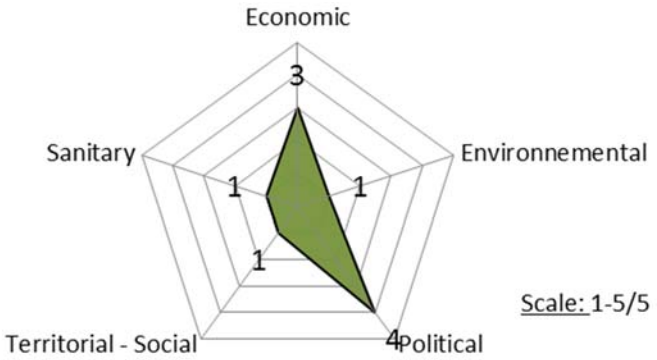
Impacts 2

Highlighting the impact of low doses of pesticides should lead to an in-depth review of the standards applied to the use of pesticides to protect crops. The flipside is less protection of seeds, the negative economic effect of which is difficult to evaluate. To date, the impacts are not obvious, because of other problems that affect the health of bees. The positive long-term impact on bee populations has yet to be analysed. Several small companies have positioned themselves and are setting up legal frameworks to protect their knowledge in the future: in addition to Testapi (methodologies for toxicological assessments) and Apinov (hive equipment), Apiterra has an option (Licence 10040 OP) to exploit a strain of bees resistant to varroa.

Impact Pathway



Impact vector



Impact dimension	Importance (/5)	
Economic	3/5	3 types of players affected by policies designed to protect bees: - Plant protection industry: €200M/yr loss of earnings - Farmers: loss of seed protection by coating, but gains thanks to more efficient pollination - Beekeepers: gains in honey production
Political	4/5	Extensive media coverage: The extent of media coverage can be measured by the number of media citations, reach (ex 20:00 news programmes), audience diversity and notably the public at large: in March 2014, media citations amounted to 539, of which 76 at international level. Widespread use in public policies: Use in public policies comes into play at European and worldwide levels, in line with policy stakes. The larval test has become a test of reference in OECD countries in applications for approval of new plant health chemicals (OECD registration in July 2013). In 2012, the ministry of agriculture issued decrees restricting the use of chemicals and in 2012-2013, defended its decision to ban various active substances at European level. Strong effect in generating new ideas: Revealing the impact of low doses is leading to a thorough re-think of standards for the use of pesticides to protect crops. Importance of relevant public policies: The loss of bees is a source of great public concern. High economic stakes, complex role of bees as insurance for preserving biodiversity to be exploited and future economic impacts.
Environnemental	1/5, potentially 5/5	Improved monitoring of the state of beehives, especially in high-risk industrial sites